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Working Paper:
Animal and Rabies Control in Joint Operations Areas

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Working Paper: Animal and Rabies Control in Joint Operations Areas

1. The purpose of this paper is to be a comprehensive resource regarding the rabies virus and critical factors to consider while developing courses of action for control programs; the intended audience includes working groups and individuals who deal with feral animal control. This document is an information resource only and is not intended to provide specific courses of action for program implementation. This paper provides a comprehensive overview of the epidemiology, clinical signs, and etiology of rabies, as well as diagnostic modalities and current control measures and techniques. A comprehensive understanding of the virus and the environment in which it survives is essential to carrying out appropriate assessments and developing improved control methods to be used in Joint Operations Areas (JOA).

2. Rabies Etiology, Pathophysiology, and Epidemiology

a. Rabies is a rapidly progressive and fatal encephalitis caused by a lyssavirus in the family *Rhabdoviridae*. Lyssaviruses are RNA viruses that most commonly exhibit intraspecies transmission; however, the rabies virus commonly spills into other species. The disease is transmitted through introduction of infected saliva into the body via bites, scratches, mucosal exposure, or rarely through inhalation of aerosolized saliva in enclosed spaces (caves with infected bat colonies). Common vectors include medium to large terrestrial mammals and bats. Small mammals, including rodents, rarely survive an attack by a larger rabid animal and therefore are not considered competent vectors. Rabies should be considered in the differential diagnosis for any animal presenting with neurologic signs since all mammals are susceptible to infection with the virus.

b. Retrograde transport moves the virus from peripheral nerve axons at the point of entry to the central nervous system. Upon entry to the central nervous system, the virus causes non-suppurative encephalitis and concentrates in the parotid salivary gland. The virus becomes transmissible upon reaching the salivary glands, which often occurs prior to the development of clinical signs in the animal. Clinical signs are a result of disruption of upper motor neuron activity, resulting in rigid paralysis. Animals appear lethargic with hypersalivation and anorexia. Two rabies syndromes are recognized in animals—the paralytic or “dumb” and hyperactive or “furious” forms. Dogs, horses, and bats usually experience the dumb form of rabies, in which lethargy or stupor is the predominant symptom. Cats and cows usually exhibit the furious form, where neurologic changes cause ferocious attack behavior. In both syndromes, animals exhibit progressive paresthesia and paralysis until suffocation and death occur due to diaphragm failure. Disease progression in humans is quite similar, but with a noted hydrophobia associated with the inability to swallow.

c. Globally, the canine variant of rabies virus is the leading cause of human disease. Canine rabies is endemic in areas where 90% of the world population resides (WHO Expert Consultation on Rabies 2005). Wildlife variants of rabies have developed in countries where canine rabies is present. Canine rabies is the likely origin of the raccoon, fox, and skunk variants in the United States. Human disease incidence has

dropped precipitously in countries with successful canine rabies control programs. A new variation of rabies was recognized in Australian bats in 2000. This novel bat strain is currently the leading cause of human disease in countries that have successfully controlled canine rabies. The World Health Organization estimates that rabies causes 55,000 deaths annually around the world, though at the 2011 World Rabies Day conference, the estimated number of annual deaths was reported to be closer to 70,000. Individuals under 15 years of age make up 30 to 50% of cases worldwide (Bourhy et al. 2010). The majority of human cases occur in Asia (95%) and of these, 99% are transmitted through contact with infected dogs (Bourhy et al. 2010).

d. Feral animal populations are a significant source of human transmission, especially in areas where humans and feral animals co-habitate. Human establishments provide sources of shelter and food for stray/feral animals, increasing survival and reproductive capacity in feral animal populations. Three stray animal populations are of concern: free-roaming owned animals, ownerless animals that are fed regularly, and feral animals that scavenge for food. Urban settings and human settlements provide the greatest opportunity for feral animals to successfully meet their nutritional needs, making populated areas a preferred habitat and increasing the reproductive capacity of animals which is attributed to improved nutrition. Without appropriate vaccination and population control, feral animals contribute to the maintenance of sylvatic rabies cycles in local wildlife and increased rabies risk to humans.

3. Animal Rabies Tests and Diagnostics

a. Serologic testing measures the effectiveness of rabies vaccination in animals and humans. A level of 0.5 International Units (IU) of rabies antibody per milliliter (ml) of serum is considered an acceptable level of immune response to vaccine (World Organization for Animal Health 2011).

i. Fluorescent antibody virus neutralization (FAVN) and rapid fluorescent focus inhibition test (RFFIT) detects antibody titers in vaccinated animals by assessing the neutralization of virus in standard assays against serum from the animal in question. These are the World Organization for Animal Health's prescribed tests for international trade (World Organization for Animal Health 2011). Therefore, movement of animals internationally is authorized based on the results of these tests by all countries in the World Trade Organization. Of the two tests, the FAVN is automated and easier to run for large numbers of samples. The RFFIT is a more rapid test but requires individual slide manipulation. The cost and supplies are similar for both diagnostic tests (Ed Cooper, personal communication, 8 November 2011).

ii. Enzyme linked immunosorbent assays (ELISA) test kits do not require direct handling of the rabies virus. Those that are approved by the World Organization for Animal Health are a prescribed test for international trade. These tests can have

variable sensitivity and specificity which is especially problematic when comparing results between laboratories (World Organization for Animal Health 2011).

b. Antigen Detection Testing. Direct fluorescent antibody test (DFA) is the gold standard detection method for the rabies virus in suspect animals. The test is rapid, sensitive, specific, and inexpensive, although the sensitivity can vary with the quality of the sample, the strain of lyssavirus, and the experience of the laboratory staff conducting the test (World Organization for Animal Health 2011).

4. Rabies Surveillance in Endemic Areas

a. Wildlife

i. Wildlife surveillance is often performed in conjunction with an oral bait vaccination program. Determining prevalence in a previously unvaccinated population in endemic areas is not necessary for two reasons: rabies is fatal to infected animals and infected animals only develop antibodies in the terminal stage of disease (Radostits 2007). Surveillance is only conducted after vaccination campaigns, when antibodies are likely to be present.

ii. Wildlife population sampling is challenging due to poor data on population size and poor access to the populations. This impacts the ability to sample and the magnitude of sample sizes. Blood samples for testing are often obtained from a variety of animal sources, such as trapped animals, hunted animals, and road kill. Any wild animal captured in response to a potential rabies exposure (bite, scratch) is tested first as a human exposure risk using the DFA test. If the DFA test is negative, the animal may be tested for rabies antibodies if an oral bait vaccine program has been used in the area in which the animal was captured.

b. Domesticated Animals

i. Surveillance for domesticated animals is performed using DFA testing in certified laboratories. All captured animals displaying neurologic signs and all euthanized animals that were involved in a potential human rabies exposure should be tested. Animals testing both positive and negative to rabies should be recorded and used as a measure of rabies in the area by calculating the number that test positive over the total number tested.

ii. Animals that receive an injectable vaccination should be given a vaccination ID tag or permanently marked as vaccinated through ear notching, tattooing, or microchipping. The use of oral bait vaccines containing biomarkers should be considered in surveillance programs. If an animal is trapped, tests can be performed to determine whether or not the animal received an oral bait vaccine. U.S. Army laboratories currently performing DFA testing for rabies include the Public Health

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Command Region-Europe's Department of Laboratory Sciences, and the Department of Defense's Food Analysis and Diagnostic Laboratory (FADL) at Fort Sam Houston, Texas. The FADL has expertise in Oral Bait Vaccination program laboratory testing as they have assisted the state of Texas in the laboratory component of the coyote oral bait vaccine programs.

c. Human Cases

i. All human cases *and* all potential exposures should be reported using case reports. These should include the following information: unique identifier, name, age, geographical location, date of onset of rabies symptoms (when applicable), date of exposure, location of exposure, type of exposure, treatment provided, date pre-exposure vaccination series (if any) was completed, the final health outcome of the patient, details of the biting animal to include its vaccination history, samples taken, results of sample testing, and final outcome of the animal.

ii. These case reports should be aggregated at the local, regional, and national governmental levels. These can be assessed to determine the human rabies incidence rate in different areas; the human rabies exposure in temporal and geographic terms; the animal most associated with human disease; the most common method of exposure (bite, scratch, or saliva contact); and demographics of the most common patients or most likely to be exposed or infected (age, gender, occupation, etc.).

d. Summary reports of the animal and human surveillance information should be readily available with quantified, easily understandable information. Reports should be disseminated to preventive medicine and medical personnel or activities to include Medical Treatment Facilities, Combat Support Hospitals, Preventive Medicine Teams, Field Sanitation Teams, Brigade Combat Teams, Medical Detachment Veterinary Services and the Support Battalion Surgeon's Cell. Updated information should always be kept at the Public Health Command as well as the relevant COCOM Surgeon's Office. Local government entities concerned with public health, human health, and agriculture or wildlife should also receive summary rabies reports.

5. Military Operations and Rabies

a. Benefits of Animal and Rabies Control Programs in Support of Military Missions

i. Effective stray animal and rabies control programs on operating bases have tremendous benefits in force health protection. Appropriate stray animal population control measures result in decreased contact of Service Members with feral and stray animals, reducing the risk of animal bite injuries and rabies transmission. These programs also provide for healthier animal populations with decreased rabies incidence on operating bases due to the following: 1) population stability, which decreases fighting between packs that can be a side effect of standalone euthanasia programs; 2)

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decreased population sizes and less in-fighting among animals for scant resources; 3) rabies-immune populations conferred by rabies vaccination programs; and 4) castrated male dogs, resulting in fewer aggressive dogs and a reduced number of bites to animals and humans overall.

ii. Not only are health benefits realized with appropriate control measures, but financial and manpower advantages are gained as well. Lost manpower hours due to injury and evacuation from animal bites are minimized. Costs associated with post-exposure rabies prophylaxis, tetanus vaccination, and antibiotic treatments associated with bite injuries are curtailed.

b. Occupation of a country includes the creation of housing areas for troops and operational planning space. This is often in undeveloped areas containing native wildlife or stray animals; the large population influx leads to increased access to food, water, and shelter for these animals. Generally, feral animals have lower reproductive rates than owned or cared-for dogs and cats. This dynamic is altered when the feral animal environment becomes urbanized or suddenly has increased resource availability (WHO Expert Consultation on Rabies 2005). Current animal control efforts in Joint Operations Areas (JOA) consist entirely of trapping and euthanizing animals, including stray/feral dogs, cats, and wildlife. The goals of this policy are to reduce human-animal contact, the zoonotic disease reservoir population, and the likelihood of human injury by an animal (United States Forces-Afghanistan Headquarters 2010). In reality, this method of animal control is counterproductive and leads to increased inter-dog aggression, lack of population control, and may even contribute to the spread of rabies in the area. Worldwide experts in animal control and rabies prevention have demonstrated that trap/euthanize policies are ineffective. The World Health Organization (WHO) is an internationally recognized source for public health issues, including rabies prevention, and has published multiple documents on managing stray dog populations and rabies. They have concluded that euthanizing is ineffective: "There is no evidence that removal of dogs alone has ever had a significant impact on dog population densities or the spread of rabies... Attempts to control dog populations through culling...have generally been unsuccessful" (WHO Expert Consultation on Rabies 2005). Canine rabies control was recently addressed during a World Organization for Animal Health (OIE) conference on eliminating rabies in Eurasia. It was a foregone conclusion that culling dogs as a primary means of rabies control has no impact on rabies transmission; most countries have discontinued this practice in favor of a more effective, comprehensive approach (World Organization for Animal Health 2007).

c. The euthanasia-only method of animal control is not endorsed by any animal organization or public health entity, does not control stray animal populations, and promotes instability within the population (Communicable Disease Working Group on Emergencies HQ 2001; World Organization for Animal Health 2007). When dogs are removed from operating base populations, other dogs quickly fill the void created. Operating bases are particularly attractive because they provide stray animals access to food and water that cannot be found in their normal environment. It is likely that

standalone euthanasia also increases inter-dog aggression due to the breakdown of pack dynamics, thus increasing bites between dogs and the potential for rabies transmission. In areas of growing dog populations, such as the Serengeti or Ngarango wildlife preserves in Africa, increased population densities did not exhibit increased rabies transmission between dogs (Hampson et al. 2009), but this study did not account for the impact of disrupted pack dynamics in areas where voids in the ecosystem are constantly being created. Increased rabies transmission may occur, but verification of this hypothesis would require further study. Nonetheless, scientific studies indicate that current methods of animal control in JOAs either fail to negate, or actually increase, the risk of rabies transmission to Coalition Forces as well as to local nationals who work on the base or live in the surrounding area.

d. General Order #1B prohibits keeping pets or mascots in a JOA. All echelons of leadership recognize that this order is not enforced or followed by DOD Service Members (SMs). Housing and feeding of pets and mascots by SMs has led to the creation of organizations that attempt to import these animals back to the United States as pets. In 2008, this resulted in the importation of a rabid dog (Mangiére et al. 2008). Regular news reports and photos show SMs with a variety of local animals that are not authorized, and a query on an internet search engine quickly proves this point (Slodysko 2011). The military has a long-standing history of animals and Soldiers bonding during times of war. Civil War Soldiers even brought their pets with them from home or adopted a mascot that travelled with the unit. In World War I, small dogs and cats were common pets of troops along the front lines. They described the animals as providing a normal experience to the highly abnormal experience of war (Connecticut Military Department 2011; Canadian War Museum 2011; McConnaughey 2010). Perhaps one of the most famous was General Patton's bull terrier, Willie, who was with him from 1944 to his death in 1945 just prior to his redeployment. Troops have always adopted pets while deployed, and the last decade of war has reaffirmed this trend, despite General Order #1B. This historic habit of adopting pets puts Service Members at increased risk of rabies transmission in all areas, but especially in areas where rabies is endemic.

6. Components of a Rabies Control Program

a. Successful stray animal and rabies control programs are comprehensive and multifaceted. Components of an effective program include mass parenteral vaccination, supplementary oral vaccination, stray animal population management, and surveillance-based monitoring of the program (WHO Expert Consultation on Rabies 2005). It is unlikely that a stray animal/rabies control program would be 100% effective in a JOA without the inclusion of each of these components. Comprehensive programs have documented success in stabilizing populations of rabies-free animals and reducing the risk of human-animal interaction and rabies transmission (WHO Expert Consultation on Rabies 2005).

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b. It is important to recall that there are three categories of canines in an area (Meslin 2007). First are the owned dogs, which are readily accessible for vaccination and castration or ovariohysterectomies. Second are the community dogs, which are also reasonably accessible for vaccination and castration or ovariohysterectomies, but at greater cost since it is unlikely that the cost of the vaccination/neutering will be covered by the community. Feral animals are the third category. They are unable to be caught for parenteral vaccination or reproductive controls without some great effort. All three groups of dogs exist on many Forward Operating Bases (FOBs). Vaccination, animal control, and surveillance methods are presented here.

c. Parenteral Vaccination

i. Parenteral vaccination refers to a subcutaneously administered rabies vaccine. To achieve rabies control in a given population, at least 70% of the animals within the population must be vaccinated to confer “herd immunity” (WHO Expert Consultation on Rabies 2005; Totten et al. 2010). On U.S. FOBs, it will be difficult to achieve this percentage of vaccinated animals through parenteral vaccination of trapped animals. Targeted mass trap, vaccinate, release programs and/ or supplementation through oral rabies vaccination is necessary to reach the desired endstate.

ii. Inactivated rabies vaccination that meet WHO standards should be used. Parenteral vaccines require cold chain management and there are many vaccines recommended for canine use by the National Association of State Public Health Veterinarians (NASPHV) in their Compendium of Animal Rabies Prevention and Control (2011). The NASPHV is endorsed by the AVMA. It advises that vaccination occurs under the supervision of a veterinarian on the premises and that a supervised individual is trained on how to properly store, handle, and administer the vaccine to animals (Brown et al. 2011; AVMA 2008). Federal regulations require vaccination of imported animals as indicated by a certificate signed by a veterinarian from the country of origin (Public Health Service and Department of Health and Human Services 2003), but it does not address domestic animal vaccination policies or mandate federal law since vaccination protocols are under state jurisdiction. Vaccination by trained individuals in deployed settings may be authorized without the direct supervision of a veterinarian for purposes of disease control, although this should be reviewed by the Judge Advocate General for legality. Color-coded ear tags or other methods of marking could be used to recognize the year an animal was vaccinated. Life spans of stray animals will likely only require one booster vaccination in order to achieve life-long vaccination (Totten et al. 2010). Parenteral vaccination generally applies to animals in the first two categories mentioned above, those reliant on humans for food and shelter and which are able to be safely captured for vaccination (Meslin 2007).

d. Oral Bait Vaccination

i. Oral vaccination is the distribution of oral rabies baits in stray animal and wildlife habitats. Supplementing a conventional parenteral vaccination program with

oral vaccination is a recognized and recommended strategy in instances where a large percentage of the animal population is inaccessible or free-ranging, or where the targeted population is wildlife (World Health Organization 2007). Different theories exist for the best use of oral bait vaccination. Some recommend that oral bait vaccines are used when 70% of the canine population is inaccessible for vaccination (Matter et al. 2000). The WHO encourages the use of oral bait vaccination when many of the dogs are free-roaming, not reliant on humans for food and shelter, and are inaccessible for parental vaccination (WHO Expert Consultation on Rabies, 2005). A robust parenteral vaccination campaign should be initiated for at least five years prior to instituting an oral bait vaccination program (Meslin 2007). Mixed populations of free-ranging dogs, cats, foxes, jackals, or other wildlife species makes U.S. FOBs in JOAs a prime venue for oral rabies vaccination. Species that are difficult to trap, such as jackals, can be specifically targeted for oral rabies vaccination. Anecdotal reports from various vector control and preventive medicine groups in Iraq indicate that packs of jackals exist in particular locations on FOBs. These packs preferentially stay away from people. Targeted baiting of known habitation areas will assist in reaching the target vaccinated percentage for rabies control on FOBs.

ii. Oral bait vaccines are recombinant vaccines. The vaccine is contained within a sachet inside a cube of bait that acts as an attractant for the local animal population. Often a biomarker is included. The presence of the biomarker in an animal indicates that it ingested the bait and allows for surveillance of bait-efficacy in the targeted area (Sidwa et al. 2005; World Health Organization 2007). Numerous oral bait vaccines currently meet WHO requirements for efficacy, such as SAG2 and R-VG. Efficacy is defined by the ability of the vaccine to protect a dog against a local canine rabies virus administered at a dose that would kill 80% of unvaccinated dogs (Meslin 2007). Oral rabies bait programs should be incorporated into endemic rabies control programs in countries with long-term governmental commitments to rabies control and that have adequate infrastructure and resources to conduct an ORV program. Oral baiting is not meant to be an initial control program, but a supplement to established parenteral vaccination programs. Even considering these recommendations, many experts encourage the use of oral bait vaccinations in wildlife and dogs in Afghanistan despite the lack of other control programs because the vaccines are effective, can be administered safely to pets, and are relatively inexpensive (Estrada et al. 2001; Dr. Ernest Oertli, ORV Program Director, TX Dept of State Health Services, personal communication, October 2011; Dr. Richard Whitten (DVM), USDA Ag Advisor, Afghanistan, personal communication, October 2011).

iii. Numerous studies have shown the efficacy of the oral bait vaccination in canines. Field studies were conducted in a wide variety of areas including the Philippines, Tunisia, India, and Turkey (Estrada et al. 2001; Vos 2003, Cliquet et al. 2007; WHO Expert Consultation on Rabies 2005) and demonstrated that the vaccine protected from infection, even when there was not a sufficient titer of 0.5 IU/ml. Further, researchers showed that the SAG2 vaccine did not cause shedding of the virus from salivary glands of vaccinated animals (WHO Expert Consultation on Rabies 2005).

e. Animal Population Control

i. Animals should not be euthanized indiscriminately, as this does not aid in rabies or population controls, and may even be detrimental (WHO Expert Consultation on Rabies 2005; Hampson et al. 2009). This is especially true when a mass vaccination plan is underway as high death rates impede reaching the goal of vaccinating 70% of the animal population and achieving herd immunity (Hampson et al. 2009; WHO Expert Consultation on Rabies, 2005). Instead, stray animal population management strategies can be implemented. Stray animal populations will increase due to reproduction or migration, despite a trap/euthanize program, until carrying capacity is reached. Carrying capacity of a given environment is a function of available food and area for territories (Foley et al. 2004). Carrying capacity can be decreased by implementing a comprehensive stray animal population management program including movement restriction, habitat control, and reproduction control. These comprehensive management programs aim to reduce turnover of stray animals, decrease the population of animals susceptible to rabies, and limit male dog behavior (such as fighting and roaming) that contributes to human-animal interactions and rabies spread (WHO Expert Consultation on Rabies 2005). Movement restriction is accomplished on FOBs by repairing breaks in fences where animals can enter. Habitat control includes drafting and enforcing animal control regulations to eliminate feral animal access to food sources, such as burn pits and trash collection sites, and compassionate feeding of animals.

ii. A first effort for reproduction control would be to implement a trap, neuter, release (TNR) program for stray animals trapped on FOBs. This program has a secondary benefit of allowing theater veterinarians to practice and maintain their surgical skills, and possibly create training opportunities for local national veterinarians. A third benefit of employing a TNR program on FOBs is to prevent the compassion fatigue currently affecting animal care specialists (68T) who euthanize trapped animals.

iii. Another option would be chemical sterilization. An injectable anti-Gonadotropin Releasing Hormone (GnRH) vaccine has shown significant promise in sterilizing vaccinated canines (Miller et al. 2004) without impacting rabies vaccine effectiveness (Bender et al. 2009). These animals can be tagged as sterilized and vaccinated via an ear notch/tag, collar, tattoo or some other distinguishing feature. At the time of capture, whole blood and stool samples can be collected for disease screening. Ectoparasites found on the animal should be collected and stored for analysis at the Public Health Region –Europe or South Laboratories. All animals that are overtly ill or lame at the time of capture should be euthanized humanely and disposed of in accordance with Army regulations and American Veterinary Medical Association Guidelines (AR 40-905 2006; AVMA 2007).

f. Rabies Surveillance

i. Veterinary and preventive medicine (PM) detachments in Iraq and Afghanistan are already performing some rabies surveillance on U.S. FOBs. Animal bite reports generated at medical facilities are forwarded to veterinary and PM detachments for action. Veterinary detachments euthanize the animal involved in the bite, if located, unless it is a working dog, in which case it is quarantined. Captured stray/feral animals involved in bites are always euthanized, and appropriate samples are shipped to the Public Health Command – Europe (Veterinary Pathology Division, Laboratory Sciences) for rabies testing. Veterinary detachments also test any stray animal showing clinical signs of rabies, whether or not a human contact occurred. More robust surveillance efforts are required if an effective comprehensive rabies/stray animal control program is implemented. This requires developing a method to adequately track the following information on each captured stray or feral animal:

- Gender
- Age group (sexually vs. not sexually mature)
- Whether or not a human exposure occurred
- Samples collected and submitted
- Euthanized versus not euthanized
- Pregnant versus not pregnant (females)
- If pregnant how many fetuses are present in the uterus
- Date and location of capture
- Laboratory results

ii. Oral Rabies Vaccination (ORV) Assessment. If an ORV program is implemented, captured animals that are euthanized for health or aggression reasons can be tested for the presence of the biomarker and an appropriate rabies antibody titer, providing a method to assess the efficacy of the program. Captured animals should be parenterally vaccinated and tagged or marked, despite the presence of an ORV program, and then released back onto the FOB, contributing to the establishment of a stable, rabies-immune population.

iii. Estimation of animal population. Population baselines are necessary to assess the impact of a program. This can be done using “Mark-Recapture” methods. There are many mark-recapture methods and some incorporate rapid techniques that can be conducted in a short time frame. For example, the following can be done in a five-day period. Based on the size of the operating base, either the whole base or a random sample of locations based on a grid will be used. Each day for five days, a team will go out early in the day when animals are most active and mark all the feral/stray dogs they see with a spray marking solution. A second team will follow the first an hour later and record the number of dogs they see as marked and unmarked. Both teams will record the gender of the animal, the sexual maturity based on the presence of dropped testes in males or developed mammary glands in females (Totten

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et al. 2010). Using the Schumacher method (Schumacher and Erschmeyer 1943), the population size will be calculated. Based on the presumed population size, the time period of capture-recapture may vary (Meslin 2007).

g. Habitat Modification. Animals' reproductive capability is proportional to their access to resources, specifically nutrition. Increased nutrition can increase reproductive success, entry into estrous, and litter sizes. Therefore, limiting access to food wastes and handouts will aid in controlling animal populations and prevent human-stray contacts as well. The importance of Soldier compliance with and command emphasis/enforcement of General Order #1B and other animal control efforts cannot be underemphasized. Command emphasis and enforcement should be extended to sanitation standards as well. Well-maintained perimeter fencing of appropriate material (e.g., not concertina wire) can provide an effective barrier between Soldiers and feral animals.

h. Other Action Items

i. Rabies control on smaller outposts can be challenging. Parenteral vaccination is the only viable control strategy for Combat Outposts (COPs) that are embedded within or near a human population. Rabies vaccination programs using primarily oral bait vaccines have been successfully implemented when animals are not amenable to parenteral vaccination (Estrada et al. 2001). Using oral bait vaccines in settings that are embedded in local communities does carry a risk of transmitting a mild pox virus infection to healthy individuals, but among healthy individuals, the pox reaction is limited. Most deployed Soldiers are vaccinated against smallpox, which may mitigate their risk. Soldiers given the responsibility of implementing an animal control and rabies control program should be trained prior to deployment on how to safely trap/capture stray and feral animals as well as how to safely muzzle and vaccinate them. Also, these Soldiers should receive pre-exposure rabies vaccination. Although these practices may encourage Soldiers to keep pets, the rabies risk is lower if it is a vaccinated animal. Vaccinated populations of strays maintained on the COP will reduce the presence of other animals and increase the stability of the feral dog population, which may reduce the spread of rabies in the area. Standalone euthanasia programs on small COPs would likely increase the cycling of animals through the COP as well as the fighting that results from the ecosystem instability of constantly euthanizing members of the population. Up to the present time, General Order #1B has been in place and has not been effective in eliminating Soldier contact with stray and feral animals; therefore, other avenues of approach should be considered. Training medics how to give rabies vaccine injections and ear-notch local dogs can be done at larger FOBs where Veterinary Detachments are based. Such events in the community would build trust and protect both Soldiers and members of the local community.

ii. Field Sanitation Teams or vector control contractors may be assets that could be trained to support the animal and rabies control programs on operating bases. Veterinary TDA and TOE units on CONUS/OCONUS installations could assist in

training Field Sanitation personnel through the stray facility on the installation or through coordination with a local animal control office.

iii. Veterinary assets in JOAs are already fully engaged. Additional support would need to be identified. Provincial Reconstruction Teams or Civil Affairs veterinary assets could assist if the FOB/COP Rabies Control Plan included increasing the capabilities of local professionals in surgical and medical skills or in a program that trains local public health personnel on instituting a rabies control project. Other options include deploying Specialized MEDCOM Response Capability (SMRC) teams to initiate these programs and support them as necessary. These teams should include a veterinarian (64A), epidemiologist (MPH with epidemiology focus, MS epidemiology, DrPH or PhD epidemiology) (64B), as well as skilled technicians (68T).

i. Cost Effectiveness of Rabies Control at the Human and Animal Levels

i. Scientific articles have proven the cost-benefit of a rabies control model (Hampson et al. 2009). A rapid assessment and pilot program could provide reasonable data to build a reliable simulation model for the area of operation. This could be done as intelligence preparation of the battlefield during early stages of long-term engagements to decide what intervention strategy would be most beneficial. An appropriate software program could be incorporated in the pilot study to build a model framework where changing parameters could be applied for the specific scenario/location.

ii. Pre-exposure human prophylaxis as a preventive measure to rabies is neither practical nor cost effective. The rabies pre-exposure series consists of three vaccines. The Defense Logistic Agency procures Rabavert vaccine for \$121.23 for a one-dose vial, making the pre-exposure vaccination series cost \$363.70/patient. Vaccination of one million U.S. Soldiers would cost \$36,370,000. This does not include the cost of titers and booster vaccinations throughout Soldiers' careers. However, pre-exposure vaccination of U.S. personnel does not confer benefit to the local population as occurs with animal vaccination, and it does not eliminate the need to for post-exposure treatment: two doses of vaccination would still be required to treat rabies-risk exposures. The need for HRIG, however, which is substantially more expensive, is eliminated with pre-exposure vaccination.

iii. Post-exposure prophylaxis for SMs involved in a bite/scratch incident includes an injection of HRIG (10-ml vial) followed by 2 to 5 rabies vaccinations depending upon the immune status of the Soldier. Deployed Soldiers taking anti-malarial chemoprophylaxis who are potentially exposed to rabies are vaccinated five times under current Centers for Disease Control and Prevention (CDC) guidance. HRIG costs \$109.76 for a 10-ml vial according to the Defense Logistics Agency and the vaccine costs \$121.23 per dose (ACIP). This means the overall costs for post-exposure prophylaxis is \$594.68 (4 doses) or \$715.91 (5 doses) per patient. According to the Armed Forces Health Surveillance Center, 643 bite incidents were reported in Iraq and

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Afghanistan from 2001 to 2010 (Armed Forces Health Surveillance Center 2011). This is a conservative number since many bites and other exposures remain unreported, and theater electronic medical records for reported events were not consistently captured by central databases during this period. For Service Members with potential rabies exposures, 5 doses of vaccine are given. Therefore, the estimated cost of post-exposure vaccination in Iraq and Afghanistan is about \$460,330.13, which does not account for lost duty time, tetanus vaccinations, antibiotics, surgical treatment (when indicated), and use of MEDEVAC and other transportation resources.

iv. Costs for animal rabies control include vaccination and potential reproductive sterilization expenses. These costs were calculated using data from the Veterinary Services at Fort Carson, Iraq Joint Operations Area, and The Department of Defense Military Working Dog Hospital, Lackland AFB, TX. Rabies parenteral vaccination costs \$1.75 for the vaccine, needle, and syringe. The castration and ovariectomy costs are estimated for a dog from 11 to 50 pounds is \$37.17 and \$52.07, respectively. Euthanasia costs \$6.74 (Fort Carson) to \$12.00 (Iraq) for a 50-pound dog depending upon the amount of euthanasia solution used. Beuthasol is \$0.73 per ml at-cost and Fatal Plus is \$0.26 per ml (CONUS). If 10,000 canines are vaccinated in-and-around the operating bases, the base costs would be \$17,500. If at least 60% of animals on a FOB containing 500 dogs were reproductively sterilized, the cost would be $(150 \text{ dogs} * \$52.07/\text{spay}) + (150 \text{ dogs} * \$37.17/\text{neuter}) = \$14,000$. If GonaCon or another chemical sterilant becomes available or a study is initiated in collaboration with the USDA, the economic and time cost would drop dramatically while continuing to significantly decrease reproductive capability.

7. POC for this document is MAJ Karyn Havas at 410-417-2859 (DSN:867) and Karyn.a.havas@us.army.mil.

Annex

1. References

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